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Ecolibrium

The skin we're in

Optimising building facades.

AIRAH

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The skin we're in

When done well, a high-performance façade can have as much bearing on the performance and comfort of a building as any other design element. So why aren't they finding their way into every project? Sean McGowan dives in to the issues of façades and air tightness with a panel of local industry leaders, including Atelier Ten director Paul Stoller, M.AIRAH; Inhabit Group principal Darren O'Dea; Grün Consulting principal consultant Clare Parry, M.AIRAH; Arup principal Haico Schepers; and Cundall director Caimin McCabe, M.AIRAH.

Ecolibrium: What is a high-performance façade and what makes it so?

Stoller: A high-performance façade is one that is designed to respond intelligently to the many competing performance demands: balancing daylight while controlling solar gain, allowing views out and in – unless protecting privacy within – allowing natural ventilation while eliminating uncontrolled infiltration, providing the right amount of thermal insulation, blocking rain and condensation while allowing moisture to move in the correct directions, and providing shelter and

Efficient, effective, and eye-catching – SAHMRI's façade balances performance with panache.

security. All the while, it is meeting a whole host of pragmatic budget, program, fabrication, and installation requirements.

Above all, a high-performance façade must be a successful part of a larger architectural logic – in other words, façades have to look great and feel right for the building.

Parry: A high-performance façade is efficient and effective. This is quite a basic premise that in reality includes being well insulated, without thermal bridges, airtight, and fulfilling a number of other functions such as being aesthetically pleasing, sometimes structural, and effective for daylighting and glare control.

Being able to perform all those functions makes it extremely difficult to perfect, but possible. A high-performance façade ultimately serves the occupants of a building by providing a pleasant, comfortable and healthy space to occupy.

Schepers: Every façade is called high-performance at the moment! Every time someone puts high-performance glazing onto a façade it seems to attract the label of "high-performance façade". But really does a low-E coat a high-performance façade make?

So what would be my definition? It would probably be a façade that significantly exceed current standards and expectations for waterproofing, energy transmission, acoustics, thermal, and visual comfort. I also like the idea that it can do more than a normal façade. Can it ventilate the building without noise or operate responsively to occupant needs? Can it clean itself or be compostable? The answer to all these questions by the way is potentially, yes.

Secondly, a high-performance façade should be one that provides an integrated envelope solution. By that I mean that it provides a solution that is more than mere cladding – its zone of influence extends beyond the 200mm perimeter cladding zone into the occupied space itself, and is integrated with the building performance. For example, can it remove the need for air conditioning for at least the perimeter zone, or remove the need for ducts?

McCabe: In addition to the attributes raised around comfort, daylight, solar glare, thermal and air tightness, a façade needs also to be maintainable, readily cleaned and meet budget provisions.

O'Dea: High-performance façades are notoriously difficult to define given the multitude of performance attributes. It is probably fair to say that an accepted definition for what constitutes a high-performance façade is simply not found in literature or dialogue today.

Ecolibrium: Are high-performance façades – and their impact on building performance – well understood by building owners, developers and other key stakeholders?

McCabe: The necessary attributes of a high-performance façade are not generally well understood by architects, building owners and operators/users.

There is a tendency to have too much effort combating the detrimental effects of large areas of glass. Facades are also invariably judged in terms of cost, aesthetics and access to views, rather than occupant comfort or environmental impact.

> "Above all, a high-performance façade must be a successful part of a larger architectural logic"

Parry: The parameters around performance are well understood, but the role of the façade and the complex relationship between these factors are not. We then have structure, architecture, fabrication, services, etc., which compete for attention and budget, and the unfortunate result is that we often end up doing a lot of things not very well. The worst outcome is aiming for minimum regulatory compliance. We're seeing better understanding, and those stakeholders are willing to learn, but there is plenty of education to be done. The façade should be a key focus for any successful project.

Stoller: While there is more understanding of the importance of façades to an energy-efficient building, the role of the façade in creating indoor comfort, or maintaining high indoor environmental quality, is still not well understood by property stakeholders. The classic case for this is the continued reliance on single-glazed façades, which cannot deliver anywhere near the comfort levels inside as a basic insulated double-glazed unit – nor the energy efficiency.

O'Dea: It is fair to say that we understand high-performance façade design in relation to material selections. We have the sticks and carrots – Section J and Green Star, respectively – to motivate designs, and these are judged by performance values that summarise mainly energy-efficiency benefits, and some might argue comfort. However, if such market mechanisms were truly a backstop for high-performance facades, we would not have Green Star-rated glass boxes in Australia.

Typically, what we fail to understand is that high-performance façade design must go beyond simple metrics, and

High-performance windows line Kroon Hall's sandstone façade at Yale University.

> The façade should be a key focus for any successful project

be driven through advanced engineering and confirmation in the built form. Designing out thermal bridges – not just at the glazing – and air-leakage, and designing in less glass, would impact performance markedly, with considerable benefit to the owner. We still have a long way to go!

Ecolibrium: What are the predominant issues around façades in Australia – and how do we compare to Europe and the US?

Stoller: An important issue finally gaining traction among the façade design community is air tightness. For an air conditioned – or heated – building, air tightness can reduce energy use significantly while increasing comfort by stabilising local temperature and humidity control.

Internationally, air tightness standards have become part of the building code for all of Australia's peer countries, and the building stakeholders have been developing experience around tightening up façades for more than a decade. The Australian building code still has no requirement for air tightness, and our builders have no awareness of air leakage as an energy or air- quality problem.

Effectively, we build brand new, highly conditioned commercial and institutional buildings as if they were unconditioned bungalows with trickle vents through the brick walls.

Schepers: One trend in Europe is higher performing façades due to tighter environmental standards such as the German Passivhaus standard. These façades target 40W/m2 peak thermal transmission, which is less than half the peak energy transmission of the best-performing Australian high-rise façades. It has led to façades that use more sophisticated double-skin systems as well as a renewed focus on fenestration design and air tightness. I call these "fat façades", as they either have two skins or windows that are smaller, and cladding becomes a more dominate feature. Façade ventilators are often integrated into the cladding zone. These façades are often used in conjunction with mechanical systems, which in turn provide only heating – and sometimes cooling – but no or limited ventilation.

McCabe: Although slowly improving, façade design in Australia is behind other developed countries due to milder climates, lower building code requirements, geographic isolation from high-tech manufacturing, and historically fewer high-rise buildings.

Façades must be appropriate to need, and re-thought from first principles. They need to let in useful daylight, keep unwanted heat out, and be airtight. Although increasing in use – due to requirements to meet NCC/BCA requirements in residential development and NABERS Energy in commercial developments – double glazing, for example, is still not generally used, particularly in some states and territories.

Parry: While the tide for high-performance façades is turning somewhat, it's generally slow and not universal. The market leaders continue to streak ahead while the remainder of the sector continues to deliver the minimum compliance solution that is pleasing to investors. In this way, we have a split market; the top of the pack is among the best in the world and keeping pace, while the rest is – by virtue of our stagnant building code – well behind.

Ecolibrium: What are some of the challenges confronting engineers designing such façades? What impacts do architectural demands have on the engineered product?

Schepers: One of the primary issues is the ubiquitous demand by clients, architects, and prospective tenants for view, view, view. This leads the designers to create more innovative approaches to achieve the ideal glass box.

FAÇADE FAVOURITES

Our panel name-checks some superior exteriors for buildings.

Haico Schepers
- 200 George Street, Sydney
- UBA building, Dessau, Germany
- One Central Park, Sydney

Paul Stoller, M.AIRAH
- South Australian Health and Medical Research Institute (SAHMRI), Adelaide
- Kroon Hall, Yale School of Forestry and Environmental Studies, Connecticut US
- 200 George Street, Sydney

Clare Parry, M.AIRAH
- Oak Meadow Primary, Wolverhampton UK
- The Enterprise Centre, Norwich UK
- Wade Institute of Entrepreneurship, University of Melbourne

Caimin McCabe, M.AIRAH
- 55 St Andrews Place, Melbourne
- 1 Bligh Street, Sydney
- 60L The Green Building Project, Carlton, Melbourne

Darren O'Dea
- Unilever HQ, Jakarta, Indonesia
- Ng Teng Fong, Singapore
- Surry Hills Library, Sydney

Another challenge is the lack of research and innovation in façade products beyond glazing performance. For example, most façades are still just some aluminium sections screwed together with a piece of glass and some insulation. Where there are new products such as the closed cavity façade systems, they are provided by single contractors with associated tendering risks. These innovative products often have long lead times and testing and development stages, which mean they often cannot be developed for a specific job due to project deadlines.

Caimin McCabe, M.AIRAH

Clare Parry, M.AIRAH

Darren O'Dea

Paul Stoller, M.AIRAH

Haico Schepers

Stoller: Because façades are so central to most architectural visions, one of the largest challenges an engineer faces is simply getting to the design table early enough to be able to help shape the façade vision around performance criteria.

Next, engineers must be comfortable with the language and logic of architectural design so they can meaningfully participate in architectural give-and-take and iterative development – this is especially challenging for engineers who prefer to be handed a single problem to solve! Façade design is almost the opposite – the engineers should be defining the questions for the whole team to solve together. Something important about solving these challenges together is that the architectural vision can then be realised in new and exciting ways, rather than defaulting to safe but familiar façade design strategies.

McCabe: There is generally too much glass, particularly vision glass, in modern façades, with limited if any external shading. This excessive fenestration introduces glare and heat-load problems, as well as reduced comfort in perimeter zones.

The highly glazed buildings being built today are using more energy than 100-year-old buildings that have been

Articulated glazed facade at the Enterprise Centre in the UK.

> High-performance façade design must go beyond simple metrics and be driven through advanced engineering

designed to climate, limiting the extent of fenestration while still maximising the entry of useful daylight and thermal mass. The Cundall Perth and Melbourne offices are good examples.

There's also a need for realistic expectations on glare and a low – but rapidly growing – level of industry knowledge of high-tech façades. Useful Daylight Index (UDI) should be adopted rather than using Daylight Factor (DF). This will limit the areas of glass in order to achieve the criteria. This will consequently improve thermal comfort within the occupied zones. The impact this will have on the façades should not be underestimated.

The old adage of "keep it simple" is also very important, as there is an increasing drive to adopt high-tech solutions rather than simpler but equally effective approaches.

Parry: Challenges include the design team not working as such. Right at the start of a project, there is a vision to deliver a great building, but the way that is communicated to each team member and the way that is traditionally realised is vastly contradictory. There is often a silo culture, with structure, daylight, thermal performance, building services and aesthetics being fairly isolated packages that come together only when needed. And we're also very comfortable working that way as it's been happening for a long time. The process requires overhaul and not just iterative evolution.

The most successful projects are where all consultants work together to obtain a holistic solution and we remove that friction.

O'Dea: Sometimes major challenges are entirely disregarded by design teams, where aesthetical changes are made and the consequence to the performance of the façade is overlooked. This is often as a direct consequence of using Section J minimum performance values as our benchmark.

Let's use the humble curtain-wall spandrel and the role of thermal bridging to explain.

Today, the spandrel frame is all but ignored by most design teams. Blame Section J, not our engineers. As the area of vision glazing is made larger, the frame ratio for the spandrel increases as the spandrel gets smaller, resulting in a greater unaccounted-for transfer of heat.

Let me explain. Presently, it is common practice for spandrel performance to be assessed by resistance (or R-value – m^2 k/W) through the centre of the unit only. However, when we account for thermal bridging, we also need to assess the performance of the frame to provide us with a Total R-value, including frame, for better construction representation.

Assuming a typical performance aspiration of R2.8 including a typical aluminium frame, the true design Total R-value, including frame, is somewhere between R0.5 and R1.0 – depending on frame and insulation quality – representing an additional 65 per cent of heat loss or more that has not been accounted for within our energy models.

An integrated "respiratory system" characterises Surry Hill Library's façade in inner Sydney.

The distinctive hanging gardens at One Central Park, Sydney.

External automated blinds installed at Melbourne's 55 St Andrews Place control solar load. Image curtesy of Cundall.

Ecolibrium: Why do we see so few high-performance façades?

Schepers: The two key issues for this are that the façade either costs more to build or the windows are smaller. Both outcomes are a concern for owners and developers. The costs can to some degree be offset by integrated design. However, it will take an exemplar project to demonstrate that smaller windows will lease as well as larger ones, and especially if these façades can provide greater amenity. It might take a smaller, low ground-scrapper to take this step and make this breakthrough.

Stoller: There is limited demand from owners for high-performance façades. Frankly, most owners are content with a façade that simply meets code, and are not willing to invest in the design and construction time required to deal with balancing the competing façade design and delivery demands.

McCabe: The use of high-performance façades are still seen as a luxury and a niche approach, not standard. Owners are led by leasing agents rather than designers, caring less about comfort – although longer term the building may earn a reputation for being uncomfortable.

Simple buildings can have high-performing façades, but are typically not recognised as such, as they are not prestigious glass offices.

Parry: We are bombarded with messages about what sustainability is, and the vast array of tools and ratings is confusing to clients. There is a mixture of valid, responsible approaches and greenwash. The result is that most don't really know what they want and there's even a bit of sustainability "fatigue".

Regarding façades, the split incentive between capital investment and tenant benefits creates perverse outcomes. There needs to be a shift in recognising the value of great façades and high-performance buildings at all market levels.

Ecolibrium: Why aren't our buildings sealed properly, and what roles does the local climate and culture play?

Parry: Many don't realise the impact that leaky buildings have. It affects health and wellbeing, comfort, energy efficiency and even building durability. And perhaps just how to achieve a well-sealed building is just becoming more widespread. If all these factors were better ingrained we would have much better progress, not just from the demand side, but the regulatory side too. Perhaps in Europe it's been more obvious as well as more stringently regulated.

Stoller: A combination of tradition and building regulations in Europe mean that people typically sit much closer to windows in buildings there. This greater proximity of occupants to façades, plus colder outside conditions, means their building culture is more attuned to façade performance issues generally, and air leakage and draughts specifically.

Broadly speaking, building cultures in climates with freezing and thawing conditions are much more attentive to building detailing and construction quality because poor building quality will lead directly to burst pipes and crumbling walls. Building cultures in balmy climates have tended to lag behind in terms of quality all around. In countries like the US and Australia, with both temperate and cold areas, these divergent quality tendencies are reflected in differing regional building cultures. Divergent building cultures retard the advancement of building codes and standards.

O'Dea: Yes, in many parts of Australia we are lucky enough to have a milder climate and culture that allows building sealing to be a low priority. This has seemingly influenced our ability to focus on this issue within legislation or

AIRAH PUTS UP A FAÇADE

The Institute is forming a new Special Technical Group.

AIRAH is in the throes of forming a Special Technical Group dedicated to building physics.

"Over recent years there has been a lot of questions and issues raised about building envelopes, as well their construction and integrity in relation to air leakage and moisture control," says AIRAH executive manager – government relations and technical services Phil Wilkinson, F.AIRAH. "There is also a considerable amount of research and work happening in isolation around the country and overseas – we want to take things a step further by starting up a Special Technical Group focused on building physics."

For more information about AIRAH's STGs, or to get involved, go to www.airah.org.au/STG.

> "Façades need and should be re-thought from first principles"

practically, which is at complete odds from someone spending their first winter in Victoria. As many Europeans will bemoan, we are often colder in Australia than we are in Europe because the drafts are so severe.

Broadly speaking, air tightness is a product of great design and meticulous construction planning and delivery. With a focus on energy efficiency and thermal comfort, the recognised benefits in colder climates are irrefutable. Tighten your building and you will save money on annual heating and the size of your heating system, while improving the health and comfort of occupants.

McCabe: There's no real requirement for air tightness in the NCC/BCA, unfortunately, just motherhood statements with no fear of being tested to confirm. This needs to change. A key motivator for most clients – private and public sector – is to just meet basic compliancy for facades. This also needs to change.

Improving air tightness of all buildings and controlling ventilation would have a significant impact on reducing energy consumption and carbon emissions in buildings. Air tightness does not just happen because you ask for it – it needs to be designed into the façade, a skill set that is generally lacking in Australian architecture, with way too much reliance on the builder and associated sub-contractors to do the right thing. At the same time, builders and trade contractors need to be upskilled to construct for air tightness. Again, the industry currently lacks the necessary skills and knowledge to do this.

Experience has shown in other countries that once it is mandatory to test façades, designers and contractors start to design better and construct better.

Ecolibrium: Are façades and associated issues like air tightness sufficiently regulated in Australia?

Schepers: Façades are regulated to some degree by NCC but purely for energy efficiency, and this is a pretty minimum standard. The associated Australian Standards, dealing with a broader range of issues, are possibly more limited.

British and European standards are often better in relation to façade sealing and control winter design issues, and performance testing. There is also limited guidance on thermal or visual comfort issues. Although the ISO 7730 and ASHRAE 55 thermal comfort standards dealing with this are well established, in fact partially written by Australians, we are not obliged to use them here. These areas can easily be addressed progressively by the standards organisation.

McCabe: Even after being in place for more than 10 years, the requirements of Section J – Energy Efficiency of the NCC/BCA are still poorly understood and very badly enforced, particularly at "occupancy permit" stage. Buildings are still going operational, even with missing insulation and low-e coatings the wrong way round. This ideally needs addressing before, or in conjunction with, adding more requirements to the NCC.

All new buildings, residential and commercial, should have mandatory requirements for air tightness testing carried out to demonstrate compliance against NCC/BCA requirements. Setting minimum thermal and visual comfort quality would also drive better façade solutions.

There should be a transition to higher air-tightness requirements by adopting appropriate international standards. The government should provide incentives to encourage the market through tax breaks or a carrot-and-stick approach to improving air leakage in buildings. A similar approach as to Commercial Building Disclosure (CBD) scheme could be considered, which requires air leakage testing as part of a buildings sale or rental.

Parry: The building code has come a long way on thermal performance – closely avoiding taking a huge backward step in 2016 – but is very vague on the area of building sealing, and overlooks most thermal bridging. Some people tend to regard the construction code as delivering "good enough". But if you turn it around and think of it as the worst legally allowable building, then doesn't that take a different slant?

Stoller: While I don't think that the government should directly participate in much more regulation of buildings in Australia, and their façades, I do think that industry bodies like the NCC should more assertively raise standards for the built environment.

At the very least, building energy efficiency should be on a trajectory of continuous improvement with regular revision, like the ASHARE 90.1 standard in the US, which significantly increases stringency every three years. The NCC should also be stepping up performance requirements around useful daylight access, air tightness, and other performance characteristics not adequately or at all addressed by current code. ▮